

## **DAWN OF NUTRITION RESEARCH IN INDIA**

*--- Pre-independence Era*

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In India, the beginning of nutrition research on modern lines coincides with the emergence of 'Biochemistry' in the west, at the commencement of the twentieth century. By the end of the nineteenth century a number of diseases like cholera, malaria, plague, kala-azar, tuberculosis created havoc among the British and Indian Army in India and in the common man's life as well. It became increasingly apparent that the diets were deficient in proximate as well as in accessory foods. The health and physique as well as the clinical symptoms of different deficiency diseases among the people in different parts of the country, attracted the attention of two medical officers of the Indian Medical Service, D. McCay and R. McCarrison, who initiated nutrition research in this country. McCay studied the protein elements in nutrition while McCarrison devoted his attention to test the effects of natural dietaries with multiple deficiencies and imbalance on the physiological function and structure of body organs. They not only did pioneering work but also attracted the attention of Indians to join this area of scientific research. It can be said that McCarrison laid the foundation of nutrition research in India during the first twenty years of the twentieth century. The 'Central Research Laboratory' was established in 1905 at Kasauli for the scientific study of the etiology and nature of diseases in India. The 'Deficiency Disease Inquiry Unit' under McCarrison became popular which was located in the Pasteur Institute at Coonoor. In 1929 this unit was converted into the 'Nutrition Research Laboratory', the first of its kind in India. After the opening of the Biochemistry and Nutrition Section at the All Indian Institute of Hygiene and Public Health at Calcutta in 1933, chemical and biological techniques were used for accurate knowledge of the basic composition of all the ordinary foodstuffs. The necessity of diet and nutrition surveys were felt by Indian nutritionists and the 'Nutrition Advisory Committee' of the Indian Research Fund Association, was set up in 1936 with the object of coordinating nutritional work at different centers in India. Government of India recognized the Committee a year later. At the NRL Coonoor, Aykroyd and Krishnan undertook analysis of different

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foodstuffs and conducted diet surveys. At this center, Patwardhan, Ranganathan, Sundararajan and Swaminathan worked on different areas of nutrition particularly in the analysis of foodstuffs. H.E.C. Wilson and B.C. Guha at Calcutta, K. Mitra at Patna, S.P. Niyogi at Bombay and K.P. Basu at Dacca also contributed to the composition of various Indian foodstuffs. A food crisis developed in India due to the World War II and a famine broke out in Bengal in 1943. In 1944, the Nutrition Advisory Committee recommended daily allowances for calories and various other nutrients for Indians of all ages. During the pre-independence era, Indian nutritionists worked hard with meager provisions of funds and facilities and accumulated adequate knowledge to improve the nutritional status of the population.

**Key words:** Beri-beri, Biochemistry, Dietary Allowance, Famine, McCarrison, Nutrition and Diet Surveys, Proteins, Public Health, Vitamins.

### INTRODUCTION

The roots of nutrition, as we know it today, began many thousands of years ago in a science called 'herbology', the use of plants for specific purpose. The ancient Indians believed that the answers to all of man's illness were to be found somewhere in the Nature and studied the power of plants. The ancient Indian medical texts describe in detail the digestibility, nutritive values and medicinal properties of different palatable substances of various classes, mainly derived from plants. From the time of Caraka and Suśruta till the 17<sup>th</sup> century work '*Bhāvaprakāśa*' by Bhāvamiśra, a number of medical texts known under "Ayurveda" had been written by the Indians. The Ayurveda taught '*āhāratattva*' and '*dinacaryā*' which used to play important role in the maintenance of health and vigour.<sup>1</sup> The '*āhāratattva*' points to the fact that though satisfaction of hunger is usually the primary criteria for adequate food intake, for sustaining healthy and active life, diets should be planned on sound nutritional principles. Long before the vitamins and minerals were discovered to be essential parts of our nutrition, ancient Indians through trial and error methods, developed food habits that used to provide the essential vitamins and minerals and helped to formulate diets similar to the 'balanced diets' developed only after 1940 in the West. With the advent of the Muslims, Portuguese, French, Dutch and finally the British in India, the Indians had to change their lifestyle and food habits; the teachings of '*dinacaryā*' and '*āhāratattva*' went into oblivion with the passage of time. The common people slowly became victims of different diseases.

Moreover, the Indians lost confidence in their own system of medicine when the physicians failed to prevent spreading of diseases like cholera, kala-azar, malaria, plague and tuberculosis that created havoc in the common man's life from the sixteenth century. By the end of the nineteenth century a number of diseases in India was deficiency diseases due more to a badly chosen diet. During 1891-1901 severe droughts and famines also played a major role in the non-availability of proper nutritious foods. However, if there was enough food in quantity to prevent the great majority of cultivators from going hungry, it became increasingly apparent that their diet was very often extremely badly arranged. Sir John Megaw in his lecture on "Population and Health in India",<sup>2</sup> said, in India although three meals a day is common than two, malnutrition due to unsuitable diet is the rule rather than the exception.

It seems that since modern chemistry did not develop in India till the advent of the British, no attention was paid to the composition of the foods in terms of their chemical composition, a prerequisite for modern nutrition research. By the early 1800s methods were developed in Europe for determining the amounts of carbon, hydrogen, oxygen and nitrogen in organic compounds. The chemical methods yielded a rich harvest in the field of nutrition.<sup>3</sup> It was discovered that food was primarily composed of these four elements. In 1827 the English physician William Prout proposed the divisions of foods into sugars, fats and proteins, in an article 'On the ultimate composition of simple alimentary substances with some preliminary remarks on the analysis of organized bodies in general' which appeared in the 'Philosophical Transaction'. Later in 1840 Liebig initiated the scientific study of nutrition and was the first to advance the theory of modern nutrition. Earlier in 1820, Braconnot for the first time hydrolyzed proteins by acids and discovered glycine, the simplest amino acid. Most of the amino acids of proteins were discovered by 1900. Emil Fischer devoted most of his lifetime (1852-1919) in the synthesis of proteins from amino acids and carried on the tradition of Liebig, Wohler and Kekule. Towards the end of the 19th century he greatly added to the knowledge of the structure of carbohydrates and proteins. During the course of the 19th century the chemists gradually devised methods for analysis of foodstuffs and ascertained that they were composed essentially of three main classes of organic substances, carbohydrates, fats and proteins together with various minerals and water. Thus at the beginning of the 20th century it was the accepted practice to define the

nutritional value of any foodstuffs in terms of these substances. During the first quarter of the 20th century, following upon the researches of Lunin(1881) in Switzerland, Eijkman (1890) in Java, and notably Hopkins (1912) in England - it became apparent that there were other things that mattered nutritionally in foods as well as the well-recognized main components. The newly detected ingredients, present in foods in extremely minute amounts, but nevertheless essential for the maintenance of health, came to be known as 'Vitamins'.<sup>4</sup>

In India, nutrition research started only when 'Medical Graduates' from the west, acquainted with the new discoveries of nutritional sciences were regularly recruited to the Indian Medical Service (IMS). Some of them took interest in solving the problems related to the endemic and epidemic diseases that created havoc among the British and Indian Army in India. This paper intends to present a historical account of how the deteriorating conditions of public health and onset of deficiency diseases forced the IMS officers commissioned in India to initiate nutrition research in this country and how the trend continued successfully with the participation of Indian scientists during the pre-independent era.

### PUBLIC HEALTH IN INDIA

The importance of pure drinking water and air, the relationship 'of fifth and over-crowding with disease was known to old civilizations as well as to the ancient Indians. The excavations of Mohenjodaro and Harappa (circa 2500 BC, indicate well-planned cities with a system of aqueduct supply of water and a system of latrines and drainage. Even till the end of the 12th century Indians used to follow the '*dinacaryā*' and hygiene as prescribed by Caraka. Unfortunately, ancient Indian traditions and practice of hygiene and public health was lost in the subsequent centuries and contamination of drinking water brought untold misery and devastation right up to the 20<sup>th</sup> century. The outbreak of diseases like cholera, malaria, plague, kala-azar in different parts of India among the army and the common man, forced the British rulers to think about 'Public Health' in India. A look into the health conditions of Bengal during the early 20th century revealed that there were more sickness and mortality prevailing among the people, both adults and children, than it should have been. The death rate in many districts of Bengal exceeds that of the birth rate, which also was

gradually on the decline. Much of this evil was due to the lowering of the vitality of the people brought on by ill-balanced and ill-nourishing diets. There was a severe breakout of Scurvy and Beri-beri among the British and Indian troops in Mesopotamia during the last Great European War and thousands were disabled within a short time. In India Beri-beri was first reported in a little known work of John Grant Malcomson entitled 'A Practical Essay on the History and Treatment of Beri-beri in Madras', published in 1835. The work referred that beriberi prevailed extensively in the North East coast division of Madras Presidency, long before machine milling of rice was introduced and the emigrants from these districts were peculiarly prone to attacks of the malady in their adopted homes. In the foothills of the Himalayas, 'endemic goiter' was a common scourge among the population.<sup>5</sup>

During, 1899-1900, Surgeon General Harvey, the Sanitary Commissioner with the Government of India, for the first time proposed and initiated a scheme to provide means for the scientific study of the etiology and nature of diseases in India. On 3<sup>rd</sup> May 1905 Lt Col. Sir David Simple was appointed as the first Director of the 'Central Research Laboratory' (CRL) established at Kasauli. Later in 1913 Sir Robert McCarrison, one of the pioneers of nutrition research in India, joined this Institute and investigated the cause of deficiency diseases in India. As early as 1911, the British Government of India set up the Indian Research Fund Association (IRFA) with the specific objective of sponsoring and coordinating medical research in the country. In 1881 Surgeon Major T.R.Lewis wrote, 'So far as I am aware, no systematic series of observations has been conducted on the precise food-requirements on the inhabitants of this country when undergoing laborious exertion, as compared with the requirements when the body is at rest, so that all inferences as to what these requirements are, are based on experiments made in Europe and on people accustomed to a far larger proportion of animal food than the great majority of the inhabitants of Eastern countries'. The first experiment<sup>6</sup> done on the subject was an able and interesting memorandum by Surgeon major I.B.Lyon, Chemical Analyzer to Government of Bombay. From actual experience of native prisoners in the Bombay House of Correction, Dr.Lyon devised three scales of diet on which these prisoners had been working and which had proved sufficient.

### McCAY'S CONTRIBUTION TO NUTRITION RESEARCH

Dr. David McCay of the Indian Medical Service was attracted by Russell Chitenden's work<sup>7</sup> on protein requirements for maintenance of a healthy body. He joined the Department of Physiology at the Medical College of Calcutta as a Professor and initiated nutrition research as early as 1906. Chitenden challenged Voit on his composition of the standard diet for a normal human being weighing 70 kg. After an experiment in 1889 it was concluded by Voit that a standard should be composed of protein 118 gms, carbohydrates 500gms and fat 56 gms with a total fuel value of 3055 calories as the amount of food required daily by a man of 70 kg body weight doing a moderate work. After examining the results presented from time to time by different investigators on the protein requirement of human body, Russell Chitenden in 1902 undertook systematic experimental studies to ascertain whether health and activity by human beings could be maintained over prolonged periods on a mixed diet of low content of protein. The outcome of his experiment revealed that nitrogen equilibrium could be attained by the intake of 44 gm to 53 gm (0.1 gm to 0.12 gm of N per kg) protein per 70 kg body weight per day. The results of his investigations and writings tended to upset the old established views on the standard dietaries and on the quantities of the different proximate principles necessary for the maintenance of health and vigor, and at the same time placed metabolism of the most important of the foodstuff - protein - on an absolutely different footing. His brilliant researches on the problems of nutrition stimulated students of physiology all over the world. McCay first drew attention to the low utilization of proteins from the Indian diets. He worked on the 'Standards of the constituents of the urine and blood and the bearing of metabolism of Bengalis on the problems of nutrition'.<sup>8</sup> The work recorded in that paper started in July 1906 and was carried out in the physiological laboratories of the Medical College, Calcutta. 'In the actual experiments and analytical investigations the whole staff of the physiological department was actively engaged for over a year, and it is due to the very able, loyal and willing help of my assistants that the publication of these researches is rendered possible', acknowledged McCay. He was assisted by Satish Chandra Banerjee, Assistant Surgeon and Assistant Professor of Physiology, Lal Mohan Ghosal and Madan Mohan Dutta, Demonstrators, Physiology Department, Medical College, Calcutta. McCay noticed that Bengalis

lived mainly on rice and dal (pulse). It was therefore, he thought, very probable that the diet would be found deficient in protein compared with ordinary standard diets, and would approach fairly closely to the type considered amply sufficient by Chitenden. The first part of the work dealt with standards of different constituents found in the urine of Bengalis obtained from a large series of observations on several different classes of the native populations. He made about 200 observations on Bengali students, darwans (watchman), household servants, domes and methars (depressed classes), in all 44 subjects. He noticed the low level of urinary nitrogen except one subject. The average urinary nitrogen gave a value of 5.98 gm daily. He argued that urinary nitrogen indicated the level of protein metabolism in the body, and in the case of normal healthy adults, who were maintaining a constant weight, it gave an idea of protein intake as well. His first assumption is correct but the second is not necessarily so as can be shown by references to more recent work on the subject. At the time he carried out his experiments there was no evidence to show that the type of dietary protein mixture could influence urinary nitrogen apart from the effect due to deficiencies in the amount absorbed. Based on his studies McCay concluded that ordinary standard of excretion of the urinary constituents for Europeans as stated in the physiology textbooks, could not be accepted for natives of Bengal. 'Any deduction of a clinical or "practical nature based on a comparison with those standards must be misleading<sup>8</sup>, wrote McCay. He also concluded that Bengalis lived on a diet the protein content of which was insufficient though a number of subjects were economically in a condition (well off) to take diets of their choice. The observations of McCay thus became the starting point for the assumptions regarding quantitative inadequacy and qualitative inferiority of protein in Indian dietaries. McCay's work on 'Bengal Jail Dietaries<sup>9</sup> is quite interesting. This work began on the 1<sup>st</sup> of February 1908 and went on continuously for 18 months. The ultimate object of this investigation was to devise diet scales in which the several ingredients were so combined that the maximum absorption could be obtained with minimum of waste - a point not taken notice in either Lyon's diet<sup>6</sup> or any other diet scale that had been framed for the Indian jails. McCay's experiments showed ample evidence that the amount of nitrogen offered in a diet was not the only criterion of the level of nitrogen metabolism attained on that diet. He concluded that 'it is quite impossible to frame diets, composed of Indian foodstuffs whose chemical

composition is similar to those in use in Europe because of the great differences in the absorbability of nitrogen of European and of Indian foodstuffs'. He objected that 'any adaptation from, the English prisons diet scales as suggested by Lewis or from the prison dietaries of Scotland as suggested by Major R.J.Macnamara were wrong in principle.'<sup>9</sup> The absorption from the two classes of foodstuffs was very different and very much to the disadvantage of the Indian, may account for the fact that no action was taken regarding the quantity of food materials entering into the composition of the Indian jail dietaries despite strong recommendation to that effect. McCay wrote a book on "Protein Elements in Nutrition."<sup>10</sup> In a table he showed the average quantity of protein available in the daily diet of different races living in India. The Table indicates that none of the vigorous races in India and in other parts of the world used to get less than 100 gms of protein in their daily diet. McCay concluded, 'Those people in India who used to get less than 100 gms of protein daily, eg., the Bengalis, the Oriyas and the Madrasis, fall far behind other races of India in respect to their physique and physical qualities.' This affords a striking study in comparison on the relation existing between the quantity of protein daily ingested by the people and the standard of health and vigor maintained by them. Investigations carried out by McCay during 1906-1912 were undoubtedly the forerunner of the extensive work later undertaken by different workers on the nutritive values of Indian foodstuffs.

Dr. Chunilal Bose, Chemical Examiner (1889 - 1920) to the Government of Bengal, a contemporary of McCay also showed keen interest in the nutritive value of Indian foods and wrote a number of books on foods and nutrition. While working in the department of chemistry he conducted chemical analysis of foodstuffs commonly used in Bengal and that helped to ascertain the cause of disease and ill-health in the eastern part of India. To popularize the concept of nutrition among Bengalis, he wrote books entitled 'Food', 'Health and Hygiene', 'Health in village' in Bengali. At the Adharchandra Mukherjee Lecture for 1929 at the University of Calcutta he remarked, " The science of nutrition has now reached an advanced stage of development and the knowledge of its principles is now more complete and accurate than at any time before, and, reasonably it has become more complex and highly technical. For a proper understanding of questions of 'food and dietetics, knowledge of Biochemistry is essentially necessary' ".<sup>11</sup> He chose 'food' as his particular subject of the lecture



because he felt that 'the present Indian diet is defective and ill-balanced and is directly responsible for the progressive deterioration of the physical health of the people' which is indirectly affecting the moral and economic well being of the people of this country.

### McCARRISON AND HIS CONTRIBUTION

Sir Robert McCarrison was the most outstanding figure in the history of nutrition in India. After completing his education in Ireland in 1900, McCarrison joined the Indian Medical Service in 1901. He distinguished himself by making excellent use of the opportunities that came in his way during the long years of service from 1901 to 1935, much of which was devoted to nutrition research in India. He wrote, 'there is no country in the world which affords ampler opportunities for this study,<sup>12</sup>. His first posting was as a military medical officer in Chitral. In this Northern Frontier region of the undivided India, he used to play a role similar to that of a general practitioner. Here he attempted to discover the cause of a disease prevalent in Chitral and locally known as 'Chitral fever'<sup>13</sup>. After various inconclusive experiments he left Chitral on transfer to Gilgit. He wanted to revisit Chitral to complete his observations but the opportunity never recurred. He was on the verge of the discovery that the disease did occur due to sand fly, made later by Doerr, but could not reach the goal due to transfer to Gilgit. In 1904 he undertook the classical researches on the cause of 'endemic goiter' in the foot-hills of Himalaya. His detailed investigations demonstrated that faulty diet was an important factor in the genesis of goiter. The known positive goitrogenic factors were insanitary conditions, polluted drinking water and intestinal infection; the known negative factors were deficiencies in respect of iodine, vitamin, protein and phosphate. He suggested, 'the monotheistic view of iodine deficiency as the one and only cause of goiter would receive the less veneration the more clearly the principles of nutrition and the relation of the thyroid gland to nutrition were understood,<sup>12</sup>. The empirical use of iodine in the treatment of goiter dated from 1820 after its chemical isolation. The observations of Coindet at that time proved that some cases of goiter were cured by internal medication with iodine or by its application as a salve over the thyroid gland. During 1930s iodine still remained the most potent of all remedies in the treatment of parenchymatus goiter. Not all cases, however, responded to treatment with iodine, and some were made worse when

the doses were excessive. It was while McCarrison was at work on goiter that Casimir Funk coined the name 'Vitamine'.<sup>4</sup> to accessory food factors and hinted to the fact that vitamins might be akin to substances formed in the glands of internal secretions. As a result of 10 years of inquiry, McCarrison later succeeded in producing goiter and cretinism under experimental conditions by feeding pigeons on milled rice. The effect produced on thyroid did not impress him. He pointed to the fact that birds fed on imperfect dietaries became subject to infections while those fed on normal diet were free from infections. While serving in these two stations in the western frontier region, McCarrison's attention was attracted by fine physique, powers of endurance and relative freedom from disease of certain races living there, notably the Pathans, the Sikhs and the Hunzes. He noticed that the people belonged to these races did not suffer from the major diseases of the western nations, such as, 'cancer, peptic ulcer, appendicitis and dental decay'. They were long lived and their vibrant health was in marked contrast to the high morbidity of other races in the southern parts of India. He wondered whether he found a control group of human beings with a 'near zero incidence of morbidity'<sup>14</sup>. He realized that he was observing something of unique importance. He concluded that these characteristics were related to their diet composed of whole-wheat flour, milk and milk products, vegetables and fruits with occasional meat. Later in 1913, when he joined the CRL at Kasauli, he served this diet to his stock colony of rats and was immensely proud of the virile stock he had raised over succeeding generations. It needs to be mentioned here that in 1912, E.V. McCollum (working for the U.S. Department of Agriculture at the University of Wisconsin) developed an approach to work with rats rather than large farm animals like cows and sheep and there by opened the way to the discovery of all nutrients. The rat became an experimental animal.<sup>15</sup> Using this animal, McCollum and Davis discovered the first fat- soluble vitamin, Vitamin A.

At the CRL, Kasauli, McCarrison started his investigations on deficiency diseases from 1913. He thought that single deficiency was unlikely to occur in man and that ill health might be caused by combined deficiencies. So he fed rats on the type of poor diets that were used by various Indian races and produced in the lower animals diseases similar to those frequently occurring among those races. Such originality was not expected of an Officer in the IMS and McCarrison met with repeated oppositions mainly from 'short-sighted finance officials'.

Returning from active War service in 1919, he proceeded to South India to join the Pasteur Institute at Coonoor, Nilgiris which was later popularly known as the 'Beri-beri Enquiry Unit'. This Institute was established by Lord Curzon for the treatment of rabies. Now and then McCarrison had an empty room for his own apparatus and for his assistants whom he 'often paid himself - his wife's cook was 'borrowed' to cut sections and the local post-office 'lent a clerk'<sup>5</sup>. Here he raised a stock of rats and carried out dietetic experiments on an extensive scale, being still an Officer in the IMS, attached to the Foreign and Political departments. Since he was not content merely to note the effects of selected dietaries on the growth of experimental animals, he undertook a minute and systematic examination of their glands and internal secretions and tried to find out to what extent they had become subject to infections. He never failed to have a complete post-mortem examination of all his experimental animals. He was in fact the first to have made the practice of carrying out complete post-mortem and histopathological studies of changes in the organs and tissues of animals fed on deficient diets. The institute became popular as 'Deficiency Disease Inquiry' Unit. Here he came across a little known work of John Grant Malcomson of Madras Medical Service, entitled 'A Practical Essay on the History and Treatment of Beri-beri' published in 1835 well before Eijkman started his discovery of vitamin B and the cause of Beri-beri in Java. Robert McCarrison and Ronald V. Norris started the investigation to find out 'association of endemic Beri-beri with rice as the staple article of the diet'<sup>5</sup>. The research was designed with the object of examining questions relating to (i) the condition of the growth of rice, (ii) possible differences in nutritive and vitamin-values of different varieties of paddy, (iii) the effect of various milling process and (iv) the effects of culinary procedures to which rice was subjected before its consumption. Unfortunately, financial retrenchment brought the 'Deficiency Disease Inquiry' to an end before the program could be completed. Whatever work was done by the workers, they concluded that true tropical beri-beri, endemic in certain parts of India, was due to the habitual use of dietaries on the verge of vitamin insufficiency, while sudden reductions in the already sparse vitamin intake, overwork, fatigue and exposure to cold and damp were determinants of the outbreak of the disease. However, McCarrison reported, "A century ago Indian hakims treated Beri-beri in addition to the use of native remedies — by advising their patients to substitute a 'milk and wheat diet' for

their habitual diet of rice'<sup>16</sup>. He concluded that these foodstuffs supplied those elements and complexes in which the rice diet is deficient. It was suggested to Local Governments, as an outcome of a resolution passed at the Far Eastern Congress of Tropical Medicine, that legislation be introduced to prevent the over-milling of rice, or the importation of over-milled rice, with the object to remove the occurrence of Beri-beri in India. In Indian Medical Research Memoir No 32 (1940), Aykroyd, Krishnan, Passmore and Sundararajan discussed the relation between rice and Beri-beri. It was pointed out that in the Madras Presidency Beri-beri as a serious public health problem was largely confined to the north-east coast area, including the Ganjam, Vizagapatam, Godavari, Kistna, Guntur and Nellore districts (Northern Circars) because the great majority of the population who belonged to the poor classes, used to prefer raw to parboiled rice. Parboiled rice retains the greater part of the vitamin B originally present even after a high degree of milling, because in the processes of steaming the vitamin diffuses into the endosperm. Raw rice on the other hand loses most of its vitamin B on decortication. Later in 1941, Swaminathan observed that vitamin B is less easily removed by washing from parboiled than from raw rice.<sup>17</sup> Another disease that engaged his attention at this time was 'urinary calculus' that prevailed in India. A survey of the disease provided the basis for experimental work on animals. The conclusion reached was that two categories of dietetic factors were responsible for the causation: excess of lime and some unknown agent present in whole cereal grains, notably wheat and deficiency of vitamin A in the diet. At about the same time he took interest to the very high incidence of 'peptic ulcer' in Travancore. He experimented with rats and concluded that, "in India and probably in other countries, the long continued use of faulty and ill balanced diet, deficient in good protein, vitamins and minerals, was an undoubted cause". He had also worked on the effects of different manures on the nutritive value of certain food grains as revealed by feeding experiments on animals. He showed that the same grain when grown on the same soil and watered the same way, produced grains with higher nutritive values when natural farmyard manures were used than with artificial chemical manures. Recently our agriculturists have understood the importance of natural manures for the production of nutritious crops and vegetables. As a medical man he paid attention to any disease and finally discovered that the cause of the disease lied in the general nutrition of the people. The object of McCarrison's

study was two folds: firstly to find out how does animal body go sick in consequence of deficient and ill-balanced diet, and secondly, to deduce there from, what form of sickness in the human subject may reasonably be attributed to, or connected in their origin with such foods. In 'The Study of Nutrition in India' published in *Current Science* in 1932, McCarrison advised that the first step toward the solution of the problems of nutrition in India should be to survey the food resources of the country and to classify its natural products into categories of nutritive value. This would involve biochemical analyses of many hundreds of food materials both from the point of view of the several vitamins and of other food essentials. 'The next step', he wrote, 'should be to determine what were the natural products of each Province that could best and most cheaply, satisfy the food requirements of the people of that Province and to group these products according to their cost'. He thought of the establishment of Institutes at each Presidency and Province of India which would search for cheap and easily produced food of high physiological value that would cater for its own particular problems of nutrition. Whatever work was done on nutrition in India by 1932, McCarrison contributed almost 80% and he rightly opined that 'in the study of the Science of Nutrition lies the greatest hope for the future of medicine'. He had published 150 original papers and nine books and memoirs. This reveals profound learning, intensive study and meticulous attention to details. His contributions showed that notable investigation could be done under adverse conditions with little assistance and equipments.

In his Lloyd Roberts Lecture, delivered at the house of the Medical Society of London on November 19th, 1936 Sir Robert McCarrison narrated, "Nature makes large-scale experiments upon man. After devoting many years of my *life* to the investigation both of naturally occurring disease in human beings and of experimentally induced disease in animals, I am convinced that it is only by the study of the experiments which Nature makes upon man ...that we shall reach to the final solution of the causes and origins of the diseases to which he is subjected. This is not to decry the experimental methods in research, to which modern medicine owes so much, but to insist that it must be the co-adjutor and not the master of those who seek in man himself and in the circumstances of his life for the causes and origins of human ailments. It is by field research in company with laboratory research - the one not divorced from nor lagging behind the other - that we may best prosecute our search, best make our pilgrimage along the road to truth."

### PROTEIN RESEARCH IN INDIA

The nutritive value of protein depends on its digestibility and its capacity after absorption from the intestine to supply the body with essential amino acids for growth and maintenance of the body. Owing to differences in digestibility and in the amino acid composition of proteins from different sources, proteins differ considerably among themselves in respect to their nutritive value. The problem was of particular importance to India for a major portion of protein in Indian dietaries was derived from cereals and pulses. The work on the composition and nutritive value of proteins first started in 1925 at the Indian Institute of Science, Bangalore and was later taken up by different laboratories in India where chemical and biological methods were employed. Experiments were carried out on experimental animals and human subjects as well. At the Seth S.G. Medical College, Bombay, Prof. S.P.Niyogi and associates studied the nutritive values of Indian vegetable foodstuffs<sup>18</sup>. The common Indian pulses were chosen for the scientific study as these formed the main source of protein in the Indian diet. They wanted to ascertain whether the protein were good in quality and if so, how far these could supply the essential amino acids required for growth and maintenance. It was confirmed by them that Bengal gram was the best protein food for its high net protein value. They also determined the biological values and digestibility of Indian pulses and observed that only about 50 per cent of the total proteins in these pulses would be available for the process of growth and repair in the animal body. At the Biochemical Laboratory, Dacca University, Kalipada Basu and co-workers investigated extensively on the nutritive value of proteins of Indian foodstuffs. They observed that 'rice, though poor in proteins, appears to contain first-class protein, 80% of which is retained in the body and for purpose of growth, *āman* rice is immensely superior to *aus*. Fifty to sixty percent of the pulse proteins are generally retained by the organism, the value being only 32% in the case of lentil'<sup>19</sup> K.P.Basu and co-workers also investigated on the protein value of some common fishes of Bengal<sup>20</sup>. They reported that the sun-dried 'ruhee fish' meal has a higher biological value of protein than the steam-dried meal both for the maintenance of nitrogen equilibrium and also for promoting growth in young rats. The digestibility of the sun-dried product was also found to be greater than the steam-dried product. Investigations were also carried out by Niyogi and his co-workers in Bombay

on the protein value of some common sea fishes available in that region. Swaminathan<sup>21</sup> studied the influence of varying levels of calcium intake on the Biological value of proteins. It was observed in his laboratory at the NRL, Coonoor that the nutritive value of the 'poor South Indian Diet'<sup>21</sup> for rats was increased by the addition of calcium salt and this result was confirmed by Aykroyd and Krishnan by experiments on school children. Swaminathan showed that, while the proteins of mixtures of rice and different pulses were of fairly high biological value, the additions of small quantities of skimmed milk powder to such mixtures increased the biological values of the proteins. Milk, in addition to containing first class proteins, is also rich in calcium. In 1947, K.P.Hare<sup>22</sup> first published a report of the occurrence of 'kwashiorker' or protein malnutrition in infancy and childhood where he described four cases among tea garden labourers in Assam. He was the Medical Officer (of a group of Tea Estates) of the Tingri Medical Association of Hoogrijan in Assam. After the Independence it was a challenge before the nutritionists in India to fight protein malnutrition and 'kwashiorker' in particular.

### NUTRITION RESEARCH INSTITUTES

In 1926, the Royal Commission on Agriculture paid a visit to Coonoor to acquaint themselves with the researches of McCarrison. They were impressed by the results achieved till then and realizing the importance of fundamental work on nutrition in relation to the food and agricultural policy of the country, recommended the formation of a Central Nutrition Research Institute. Acting on these recommendations, McCarrison submitted a proposal for the establishment of a 'Nutrition Research Center' under him at Coonoor. It was not until 1929 that he obtained proper facilities for research through the assistance of Lord Linlithgow who was in the governing body of the Indian Research Fund Association (IRFA), formed in 1911. IRFA accepted the proposal and converted McCarrison's "Deficiency Disease Inquiry Unit" at Coonoor into the "Nutrition Research Laboratory" (NRL). Till 1930, NRL was the only institution primarily devoted to researches on nutrition. It should be mentioned here that without the financial support from the Indian Research Fund Association, McCarrison could not have conducted his researches on Beri-beri at Coonoor. The object of the Association was to promote research in medical

and allied sciences in India. McCarrison was the first Director of NRL where he undertook extensive researches on nutrition and laid the foundation of nutrition research in India. He commented that 'the science of nutrition was the foundation of a more rational medicine. Food was the instrument of nourishment, nutrition was the act of using it; but within recent years had the important relation of certain food essentials received due attention'. He also added that malnutrition was not necessarily dependent on poverty and he believed that it could exist in the midst of plenty. Later in 1935-36 when W.R. Aykroyd became the Director of NRL, he together with B.G. Krishnan attempted to devise cheap 'well balanced' diets for Indians.<sup>23</sup>

The Rockefeller Foundation of USA provided the cost of acquiring a site and contributed to build and equip an All Indian Institute of Hygiene and Public Health at Calcutta<sup>24</sup>. The building was completed in 1932 and was formally opened by Sir John Anderson, the Governor of Bengal on December 30, 1932. H. Ellis C. Wilson joined as a Professor of Biochemistry and Nutrition Section that opened in March 1933. Chemical or biological techniques for estimating quantitatively the vitamin contents of different food materials were developed only in late 1920s in Europe. Wilson used these techniques for accurate knowledge of the basic composition (including vitamins) of all the ordinary foodstuffs and undertook diet survey of the different classes and communities. In this study he was in agreement with McCarrison, that it was essential to know the constituents of foodstuffs before any detailed information on the relationship between diet and disease could be obtained. McCarrison from Coonoor cooperated with Wilson to solve many nutrition related problems. Considerable researches on the vitamin contents of various Indian foodstuffs was undertaken by the Biochemistry and Nutrition Section of this institute from its inception. It seems that the vitamin research that gained momentum in Europe, especially at the Cambridge University under Prof. Gowland Hopkins, had influenced the Indian workers too. Another institute that initiated biochemical and nutritional research was the Institute of Medical Research (now Indian Institute of Chemical Biology) at Calcutta. It was set up by a group of patriotic scientists and medical professionals on January 1, 1935. After returning from England, Dr. Biresch Chandra Guha took interest in nutrition research at the Medical Research Institute. Guha was the one of the first few Indians who received training in Nutrition Biochemistry while working under his research



guide Prof. Jack Drummond and later under Sir Gowland Hopkins in England. He witnessed the positive effect of rationing of food due to the exigency of 'Blitzkrieg' in London and surroundings on which Prof. Drummond was working at that time when he was the Nutrition Advisor to United Kingdom. It was observed that with restricted calories as compared to the pre-war non-ration days, the children were comparatively free from many common ailments and were growing surprisingly at a faster rate than had been recorded before the War. This was due to the fact that although the food was rationed, under the advice of the technical experts, care was taken to see that the ration provided were adequate with respect to proteins, minerals and vitamins. At the Medical Research Institute, Guha's work was concerned with the protein, vitamin and mineral values of Indian foodstuffs and the metabolism of vitamin C in human and experimental animals.

#### DIET AND NUTRITION SURVEY

Till 1935 there was very little quantitative information about Indian diets and dietary habits. A symposium on 'The Problem of Nutrition in India' was held in a joint meeting of the Physiology and Medical Section under the auspices of the Indian Science Congress in 1936. Dr. W. Burrige was in the chair. He opened the discussion by pointing out that the nutritional standard fixed by Voit and others for western people could not be rigidly followed in India. He advised that while deciding upon the dietary standard in India, the nutritionists should take into account that the basal metabolism and calorie requirements for Indians were distinctly lower than for the western countries. Dr. W.R. Aykroyd referred to common diseases like stone, night blindness, etc., prevalent in India which were connected with faulty nutrition. He pleaded for greater co-operation between nutrition research workers, agricultural experts, statisticians and economists. Dr. B. C Guha pointed out that the vast majority of the Indians were living on a sub-nutritional level that would inevitably lower their power of resistance. He felt the need for survey of the incidence of malnutrition in India. Guha pointed out the intimate relationships between nutrition, agriculture and public health and pressed for a close liaison between these departments. He pleaded for the adoption of a National Food Policy for India that was also powerfully advocated by Sir Gowland Hopkins and Sir John Orr in UK. Finally, Guha suggested the formation of a Central Committee for coordinating the

nutritional investigations at different centers in India. According to the suggestion the 'Indian Nutrition Committee' was set up with the object of coordinating nutritional work at different centers in India. Guha was appointed the Secretary and Convener of the Committee. In the same year, a 'Nutrition Advisory Committee' of the IRFA was inaugurated by the then Viceroy and Governor-General, Lord Linlithgow. A year later this Committee was recognized by the Government of India as the National Nutrition Advisory Committee. The main function of the Committee was to advise the IRFA in planning, coordination and promotion of nutrition research. The Committee was also called upon to advise the Health Survey and Development Committee (Bhore Committee) of the Government of India in its task of planning for the post-war development in medical relief and health organization and services. The Bhore Committee accepted the recommendations of the Nutrition Advisory Committee on nutrition research, provincial nutritional organizations, long and short term measures for the improvement of nutrition of the people of India and food supplies. One of the results of planning for nutrition research was the establishment of 'regional nutrition research units' under the IRFA. Two research units were established in 1944 — one at the Seth G.S. Medical College at Bombay and the other at the University Biochemical Laboratory at Dacca. Subsequently, two other regional units were opened — one at the University of Science and Technology, Calcutta and the other at the Indian Institute of Science, Bangalore.

Since the year 1934, short- term courses on nutrition were being given annually at the All India Institute of Hygiene & Public Health, Calcutta. In the year 1937, the facilities were also provided at the NRL, Coonoor, for the training of medical and technical personnel. The State Governments deputed suitable candidates for training at both these centers with a view to employing them in their respective nutrition organizations. But it is unfortunate that the initial enthusiasm showed by the State Governments did not last long enough to result in the establishment of nutrition organizations in all the States. Only Bihar, Punjab and Hyderabad States employed trained personnel and utilized them for public health nutrition work. In these three centers nutrition officers with not too generous facilities, carried out much valuable work before and after the War. The nutrition section in Bihar was provided with laboratory facilities. During the War, Baroda, Central Provinces, Bombay, Madras and Travancore organized nutrition sections. In most cases, the provision of funds and facilities

for work were very meager. In spite of this, the nutrition officers worked hard with excellent results. But it should be admitted that the State Governments did not realize the full significance of the preventive aspects of nutrition. In Indian laboratories much basic knowledge was accumulated but those who were responsible for the application of this knowledge acted indifferently<sup>25</sup>.

Bihar was one of the first among Indian states to take active interest in nutrition work and this was possible only for the initiative taken by Dr. K. Mitra. He accepted a post at the Bihar Provincial Public Health Service in 1927. An intensive and devoted worker, he immediately became a popular Health Officer of Patna and took interest in the nutrition and food habits of adults and children in rural and urban areas of Bihar. A modest beginning was made late in 1937 by organizing diet and nutrition surveys. Within a year he set up the first Nutrition Research Laboratory in the Public Health Department of the Bihar Government. He worked out the food values of various components of diet that were being taken by the children and adults and tried to establish a 'norm' for the essential ingredients and caloric need of the population of several districts of Bihar. He was the nutrition-officer-in-charge, and was assisted by a medical assistant, a chemical assistant and necessary field, clerical and technical personnel. The officer used to conduct experiments in the laboratory to supplement his field investigations<sup>25</sup>. The Nutrition Scheme functioned continuously for 13 years. The diet surveys conducted under the scheme pointed to the fact that the diets were inadequate in protective foodstuffs - a fault which was common to all poor Indian dietaries. Some surveys among the individual workers in Jamshedpur and Jharia showed that with an increase in income the intake of non-leafy vegetables, sugar and jaggary, oils and fats was increased whereas there was a marked decrease in the consumption of green-leafy vegetables. A resurvey during the food shortage of 1943, it was found that intake of protective foods like milk and leafy vegetable was greatly reduced. It was concluded that ignorance of healthy food habits was to a certain extent, responsible for the consumption of unbalanced diets<sup>26</sup>. This is true even today among some of our rural and urban populations. At the Bihar Nutrition Scheme over 300 different foodstuffs were analyzed for their proximate principles and mineral contents and carotene and ascorbic acid were determined chemically in 70 different vegetables. In the early years of the war dried *āmlā* (*Phyllanthus embelica*) powder was used as a source of vitamin C supply to troops in India.

The fruit was found to be a rich and easily available source of vitamin C by Indian workers. *Āmlā* powder was manufactured and supplied to the Army and a number of experiments were conducted to retain its vitamin value after drying of the fruit <sup>25</sup>.

During 1935 - 36 as a result of economic crisis, considerable attention was given, in a number of countries, to the problem of devising cheap 'well balanced' diets. Numerous pamphlets were issued by public authorities, charitable organizations, etc., which instructed the poor and unemployed how to purchase an adequate diet for a few shillings, dollars, etc. per week and often provide a variety of specimen menus for daily consumption; in India a pamphlet on 'balanced diets' was issued by the Bombay Presidency Baby and Health Week Association and achieved a wide circulation. At the NRL, Coonoor, Aykroyd and co-workers undertook diet surveys in South Indian Villages <sup>27</sup>. While trying to devise 'well balanced' diets, they paid attention to the food habits of the people concerned. They observed that in India the problem of devising satisfactory cheap 'well balanced' diets was somewhat complicated. Firstly, because there was no precise knowledge of the composition of many Indian foodstuffs, particularly as regards mineral salts and vitamins, and secondly, because it was doubtful whether the dietary standards put forward by American and European physiologists would be applicable for the Indians. They tested twelve different diets, composed of common Indian foodstuffs, on growing animals. They suggested that while chemical analysis and biological assays had provided useful information as to the nutritive value of various dietary combinations, 'the ultimate tests would be their effect on human beings'. At the All India Institute of Hygiene and Public Health, Calcutta, 'a diet survey of some families and Institutions in Calcutta' <sup>28</sup>, was conducted by Wilson and co-workers. This work was undertaken primarily as an initial step to correlate diet with physique and incidence of clinical signs of disease. The study included ten middle-class Bengali Hindu families, a Bengali male hostel, two orphanages - one Muslim and one Hindu, an Anglo-Indian School, a Marwari gate-keeper and an Oriya gate-keeper. The composition of diet was analyzed under the following head: protein, animal protein, fat, animal fat, carbohydrate, ash, calcium, phosphorous, total calories, percent of calories from dairy products and cereals, and percent of food budget spent on fruits, vegetables and dairy products. The diets, analyzed in this survey, were found to be poor in total and animal

protein, total and animal fat, and calcium and to a lesser extent phosphorous. They contained too low a percentage of dairy products and an excess of cereals. It is interesting to note that the minimum cost of a 'balanced diet' according to western standard, in Calcutta during 1936 was approximately annas 4.4 to 5.6 per man value per day; but that was beyond the means of most<sup>28</sup>.

McCay in 'Protein Element in Nutrition' gave the composition of 'average diets' consumed by various classes of population in Bengal, including cultivators and also that of an 'average' Sikh diet. Dietaries of industrial workers in India had been investigated in family budget inquiries carried out by the Labour Office of the Government of Bombay (Report of an Inquiry into Working Class Family Budget in Ahmedabad, 1928; Report of an Inquiry into the Family Budget of Cotton Mill Workers in Sholapur City, 1928; Report of an Inquiry into Working Class Family Budget in Bombay City, 1935) and by the Commerce Department of the Government of Bengal ( Report on the Standard of Living of Jute Mill Workers in Bengal, 1930). The purpose of these investigations was economic and no attempt was made to assess the physiological adequacy of the diet. In 1928 the Board of Economic Inquiry, Punjab, published an economic survey of a village in the Amritsar district in which some rough data about the food intake of a few families were recorded. A diet survey in South Indian villages by Aykroyd and co-workers revealed that the diet of rural population was often better than that of town populations because the former consumed unmilled rice or millet, and the latter usually highly milled rice<sup>27</sup>. At NRL, Coonoor, Ranganathan, Sundarajan and Swaminathan surveyed the nutritive values of 200 common Indian foodstuffs<sup>29</sup>.

### FAMINE & DIETARY ALLOWANCE FOR INDIANS

After years of researches on nutrition in Europe, it was established by scientists and nutritionists that the inferiority in physical condition as well as a large amount of preventable human suffering and disease was largely due to imperfect nutrition. The importance and urgency of the problem led the British Medical Association in 1933, the League of Nations in 1935 and 1936 to appoint expert committees to report on the optimum dietary standards and on the state of nutrition of the people in European countries. The Technical Commission of the Health Committee of the League of Nations had formulated certain standards that were published in 1936 in a report called "Physiological bases of Nutrition".

The report of the committee of the League of Nations, issued in four volumes were thorough and comprehensive, but it was noticed with great regret by the nutritionists of India that although India was a member of the League of Nations and contributed liberally for its maintenance, no mention was made about the state of nutrition and about the production, consumption and price of foodstuffs in India. The League did not even undertake any dietary survey in India as it had done in countries of Europe. There were reasons to believe that basic calorie requirement in a warm country like India should be lower than in the temperate countries. This report continued to influence the thinking of the nutritional workers throughout the world till the early years of the World War II. It was only in 1941 that the nutrition workers in the USA started examining the problem of nutritional requirements in the light of experience that had been gained during the intervening years particularly in order to meet the emergency brought about by the Second World War reaching the shore of the United States. The Food and Nutrition Board of the National Research Council of the USA agreed after careful consideration, upon a scale of daily allowance, which was published in 1941.<sup>19</sup>

The effect of World War II began to be felt in the latter half of 1942. Since then the price of foodstuffs had continuously risen together with those of other essential commodities and although the income had also increased the latter was not commensurate with the general increase in price. A food crisis developed in India and a famine occurred in Bengal in 1943<sup>30</sup> due to export of foods, denial policy, lack of transport, profiteering and undue stocking by some organizations including large employers of industrial labourers. The Government admitted that for fear of Japanese invasion rice was removed from some coastal districts of Bengal but the people were not evacuated from that area. The food crisis throughout India and the famine in Bengal forced the Nutrition Advisory Committee of the IRFA, to formulate a daily dietary requirement for Indians. The Nutrition Advisory Committee had at its disposal in 1944, two authoritative documents, viz., the one published by the League of Nation in 1936 and the Table of Allowances published by the National Research Council, USA in 1941. It is presumed that the Committee also had at its disposal certain (although not quite adequate) information on the dietary requirements of Indians based on work carried out in India, when it drew up its Table of requirements in 1944. The Nutrition Advisory Committee recommended daily allowance<sup>25</sup> of minimum

of 2400 calories and various other nutrients for Indians of all ages. These recommendations were then mainly intended to assist the Government of India in formulating their food production policy in the post war years in order to meet the needs of the increasing population. However, those dietary recommendations were somewhat defective because the information on which they were based was not as full and representative as it should have been. The committee later agreed to consider the revision of its tables of daily food allowances which recommended for calories and seven nutrients of major importance. Information on nutritive value of Indian foods was published in 1937 by Dr. W.R. Akroyd, Director, Nutrition Research Laboratory, Coonoor. This booklet, popularly known as 'Health Bulletin No 23', underwent many revisions and was widely used both by the professionals and the common man.

### CONCLUSION

Nutrition research on modern lines started in India due to the untiring efforts of a few British medical officers who joined the Indian Medical Service at the beginning of the 20<sup>th</sup> century. The emergence of 'Biochemistry' as a branch of chemistry in the West during this period solved many staggering problems of nutrition. The discovery of 'vitamins' also played an important role in the understanding of the causes of different deficiency diseases. Indian nutrition scientists and medical doctors took great interest in this field of study by conducting researches in the laboratories and also by undertaking diet surveys in different parts of the country. NRL at Coonoor, All Indian Institute of Health at Calcutta, Seth S.G. Medical College at Bombay and the Biochemical Unit at the University of Dacca played an active role during the initial period of nutrition research in India. Most of the Indian nutrition researchers got the opportunity to visit and work in different nutrition laboratories in Europe, to acquaint them with modern nutrition researches and discoveries. The composition of Indian foodstuffs, diet surveys, causes of different deficiency diseases particularly Beri-beri, Goiter, night blindness, etc, were undertaken by the Indian nutrition researchers. The Indian Research Fund Association contributed to nutrition research in India by providing funds for researches. Much knowledge was accumulated in Indian laboratories on the nutrition requirements of the Indian population. But soon it was realized that the colonial Government was not

interested to implement the knowledge for the benefit of the Indians. The scientific knowledge that was applied for the people of the United Kingdom to improve their health conditions during difficult times, were not applied for the people of India. When millions of people were dying due to starvation and malnutrition during the famine, food grains cultivated by the Indian peasants were exported to U.K. The Indian nutritionists and scientists realized that India was one country where hardly a fraction of the accumulated knowledge could be applied to the various fields of national welfare during the British rule. A number of articles were published in different Indian journals on 'The Problem of Nutrition in India', where Indian nutrition scientists pleaded to take positive measures for the improvement of the nutritional status of the people of this country. Special emphasis was given on 'Nutrition and Agriculture', 'Requirement of vitamins, minerals, proteins, fats and calories', 'Feeding of growing children and Infants', etc. Nutritionists in India pleaded that it was not the income of the individual but his physiological needs that should determine the food he would eat. The requirements of laboratories in different parts of India for the study of human nutrition was the need of the hour. The basic researches in nutrition were proposed to be the prominent feature of these laboratories by Indian nutritionists. Scientists emphasized on the importance of 'Biochemistry' as a science and the contributions it had made towards the development of both pure and applied aspects of the science of food. Attention was attracted on the processing of foodstuffs in order to preserve or enrich them. It was realized that the creation of a balanced team of nutrition scientists who would undertake collaborative research on diverse aspect of nutrition would constitute an important landmark in the field of nutrition research in India after Independence.

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